Southwest FISHERIES CENTER

HONOLULU LA JOLLA MONTEREY TIBURON

REPORT OF ACTIVITIES January-February 1989

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SOUTHWEST FISHERIES CENTER

CENTER ADMINISTRATION- La Jolla, California

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Deputy Director ..... *John F. Carr*
Planning Officer ..... *David J. Mackett*
Information Technology Services ..... *Dorothy Roll*
Executive Officer ..... *Benjamin F. Remington*

LABORATORIES & DIVISIONS

Antarctic Ecosystem Research Group, Chief ..... *Rennie Holt*
La Jolla, California
Coastal Fisheries Resources Division, Chief ..... *John R. Hunter*
La Jolla, California
Fishery-Marine Mammal Interactions Division, Chief ..... *Douglas P. DeMaster*
La Jolla, California
Honolulu Laboratory, Director ..... *George W. Boehlert*
Honolulu, Hawaii
Pelagic Fisheries Resources Division, Chief ..... *Gary T. Sakagawa*
La Jolla, California
Pacific Fisheries Environmental Group, Chief ..... *Andrew Bakun*
Monterey, California
Tiburon Laboratory, Director ..... *Alec D. MacCall, Acting*
Tiburon, California

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Antarctic Ecosystem Research Group

La Jolla, California

New Research Group

In response to the recent transfer of NOAA's Antarctic program to the Southwest Region, SWR Science and Research Director, Dr. Izadore Barrett,has assembled a new research group to pursue studies of living marine resources in the Antarctic. The group, led by Dr. Rennie Holt, Operations Research Analyst, focuses on krill, fish and their predators (pinnipeds, birds and whales). They provide advice to the U.S. delegation to the Convention for the Conservation of Antarctic Marine Living Resources (CCAMLR), part of the Antarctic treaty system.

The new group began operations immediately by conducting a 4-1/2 month cruise to the Antarctic aboard the NOAA Ship *Surveyor*. Planning sessions will be conducted in April and May to design alternative long-range strategic plans. The group will represent CCAMLR at the International Whaling Commission meetings to be held in San Diego in May; the group will also host two krill workshops in June and a baleen whale recovery workshop in September.

First NOAA Vessel in the Antarctic

The first NOAA vessel to ever work in the Antarctic returned to port recently in Punta Arenas, Chile. The NOAA Ship *Surveyor* earned the unique distinction of being the only NOAA vessel to operate in both Arctic and Antarctic ice during the same field season. Her Antarctic work was conducted under the guidance of the newly formed Antarctic Ecosystem Research Group at the Southwest Fisheries Center.

The *Surveyor* left Seattle for points south on December 4, 1988, after finishing a field season in the Arctic and undergoing a quick dry-dock for repairs. The ship stopped for fuel in Valparaiso, Chile and arrived in Punta Arenas on January 1, 1989. The field work was divided into two cruise legs conducted during the months of January and February (Figure 1). The ship last ported in Punta Arenas on March 4 through 8 before returning to Seattle on April 10, 1989.

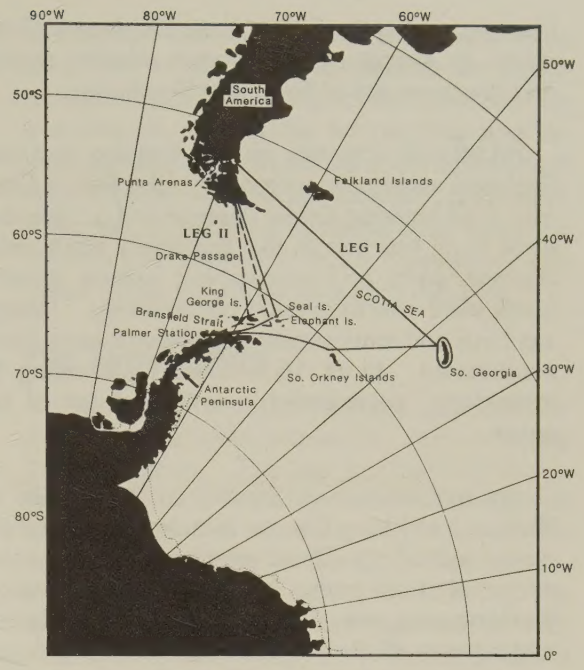


Figure 1. 1988-1989 Antarctic cruise of the NOAA Ship *Surveyor*.

Dr. Roger Hewitt (CDR NOAA Corps) designed the cruise, recruited participants, managed the logistics and acted as cruise leader on the first leg. Holt acted as cruise leader on the second leg.

During the first leg a field camp was re-established at Seal Island--a large pile of rocks, inhabited by 500 fur seals and 20,000 chinstrap penguins, jutting out into Drake Passage northwest of Elephant Island. A self-contained weather station was also established at the site to transmit year-round observations back to the States via satellite. The ship continued through the archipelago on the west side of the Antarctic Peninsula conducting ice-seal studies and making a call at Palmer Station, the U.S. biological research station operated by the National Science Foundation. Field operations then moved to South Georgia, 700 miles northeast of Elephant Island. Several bathymetric features of geological interest were investigated along the way using the *Surveyor's* Seabeam system, a high-resolution multi-beam echo sounder. A pre-recruit survey for fish was conducted on the shelf waters surrounding South Georgia using various plankton nets, several types of mid-water trawls, and a bottom trawl custom-designed for the *Surveyor's* configuration. Calls were made at the British Antarctic Survey station at Bird Island, on the extreme west end of South

Georgia, and at the British Army Garrison at Grytviken, an abandoned Norwegian whaling station and the grave site of Sir Ernest Shackleton.

Additional activities on the first leg included Seabeam reconnaissance of the Shackleton Fracture Zone crossing Drake Passage and a triple tectonic plate junction in the Bransfield Strait area. Surface water and atmospheric carbon dioxide levels were also monitored continuously. Pelagic sea birds and marine mammals were observed and enumerated. In all, 16 scientists representing 10 institutions participated on the first leg of the cruise.

An acoustic survey for krill in the vicinity of Elephant and King George Islands was conducted on the second leg. Direct sampling of krill was also accomplished using MOCNESS and bongo plankton samplers. The *Surveyor* aided cleanup and salvage efforts in the aftermath of the grounding of the Argentine vessel *Bahia Paraiso* near Palmer Station. Several underwater volcanoes and other previously unknown bathymetric features were delineated with the Seabeam system. Results of pelagic bird and marine mammal surveys were correlated with krill distribution patterns. Krill growth and development rates were measured in a series of experiments conducted aboard ship. Toward the end of the cruise the field camp at Seal Island was closed for the winter; personnel and gear were retrieved for the trip back to Punta Arenas. In all, 14 scientists representing 9 institutions participated on the second leg of the cruise.

Copies of the cruise report describing objectives, accomplishments and tentative conclusions for both legs as well as the southbound and northbound transits are available from Roger Hewitt. (R. Hewitt, FTS 893-7052)

COASTAL FISHERIES RESOURCES DIVISION

La Jolla, California

COASTAL EASTERN PACIFIC POPULATION BIOLOGY OF FISHES

Atresia in Dover Sole Ovaries

In Dover sole and other fishes with determinate fecundity, the standing stock of advanced oocytes, just before spawning, is assumed to be equivalent to the actual annual fecundity. Strictly speaking, the mean standing stock is probably never equal to the average annual fecundity because in any population some of the females resorb some of their advanced oocytes rather than spawn them. Thus, atretic losses of advanced oocytes could be a major bias in any estimate of annual fecundity and it is important to know whether the females that resorb large numbers of advanced oocytes are a significant or negligible fraction of the population. To measure atretic losses in Dover sole ovaries Biological Technician Beverly Macewicz and other staff members counted the number of atretic oocytes (alpha stage atresia) occurring in a random sample of 30 advanced oocytes. Each of the 353 ovaries used to estimate fecundity in Dover sole were analyzed in this fashion.

On the average, the fraction of the advanced oocytes that were atretic was very low with the mean = 0.015 (SD = 0.032, n = 353). A few females had as many as 20% of their advanced oocytes in alpha stage atresia, but about three fourths of the females had no atretic oocytes in the count of 30 (Figure 1).

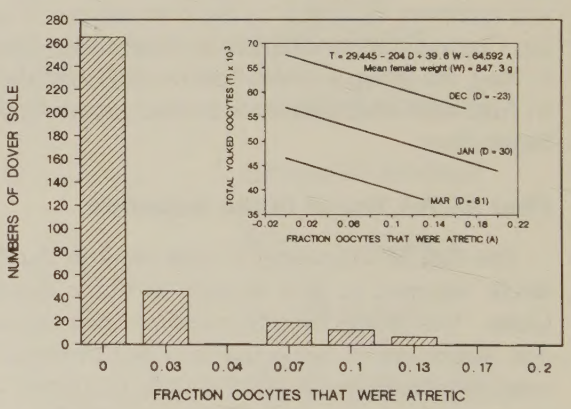

NUMBERS OF DOVER SOLE
FRACTION OOCYTES THAT WERE ATRETIC
TOTAL YOLKED OOCYTES (T) x 10³
FRACTION OOCYTES THAT WERE ATRETIC (A)
DEC (D = -23)
JAN (D = 30)
MAR (D = 81)

Figure 1. The numbers of Dover sole with various levels of ovarian atresia; inset, relation between total fecundity (T), Julian day (D), female weight (W), and fraction of oocytes that were atretic (A).

The fraction of females with atretic oocytes remained about the same over the spawning season, but the fecundity of a female was negatively correlated with the fraction of oocytes in the ovary that were atretic. We expressed this relationship using the multiple regression equation, T - 29,445 - 204 D + 39.6 W - 64,592 A; where adjusted r^2 = 41%; F is the standing stock advanced oocytes for any month December-

March; D is the Julian day; W is female weight; and A is the fraction of 30 oocytes that were atretic (Figure 1 inset). This analysis indicates that the loss in fecundity (T) was substantial in the few females where the incidence of atretic oocytes was high (A = 0.2). On the other hand, in most females few or none of the advanced stock of yolked oocytes were atretic, hence, the average atretic loss (A = 0.015) for the population was negligible as was the estimated reduction in fecundity (T). Thus, the potential fecundity for the year, based on the standing stock of advanced oocytes, was only slightly higher than the actual total fecundity for the year. (J. Hunter and B. Macewicz, FTS 893-7108 or 893-7107)

Sablefish Brood Stock Surveyed

Fishery Biologist Gail Theilacker reports that she, Eric Lynn (Fishery Biologist), Larry Robertson (Biological Technician), and Beverly Macewicz (Biological Technician) surveyed the sablefish brood stock maintained in the SWFC aquarium in January, which is the season when natural spawning occurs off southern California. The team anticipated using hormone injections to induce spawning of the laboratory stock. They measured, weighed, sexed and tagged 98 fish. Unfortunately, only 10% were females. Two females were injected, even though the egg size was less than optimal for inducing spawning, and they were transferred to tanks with several running ripe males. Maturation time will be monitored for these females. Carol Kimbrell (Fishery Biologist) and Amy Hays (Biological Aid) assisted with data recording.

Increased Dover Sole Survivorship in Captivity

The newest addition to the Dover sole brood stock, collected and maintained aboard the NOAA Ship *David Starr Jordan*, has exhibited 70% survival after 30 days in the SWFC aquarium. In the past, Dover sole survival has been about 6%, which is so poor that we questioned whether to put forth the time and effort required to bring them back alive. We attribute this increased survival to the care in capture and maintenance provided by Bill Flerx (Fishery Biologist), Dimitry Abramenkoff (Fishery Biologist), Cindy Meyer (Computer Programmer Analyst), and Susan Miller (Biological Technician) aboard ship and Eric Lynn and Larry Robertson at the SWFC aquarium. The improvements to the system that may have accounted for the success were: 1) avoiding sea urchin collections in the trawl with the fish (urchin spines impale the Dover's soft flesh), 2) placing the Dover transport tank on the ship to eliminate two net transfers, 3) cooling the temperature and increasing the oxygen in the transport tank aboard ship, 4) reducing stress by controlling pH aboard ship, and 5) adding a synthetic polymer to the tank aboard ship which forms a protective colloidal, slime coating on damaged fish skin.

Fish Sperm Frozen

Theilacker reports that she successfully preserved viable sablefish sperm using cryoprotectants. The key to obtaining motile (and presumably fertile) sperm after thawing was to decrease the equilibration time in the cryoprotectant prior to freezing. Cryoprotectants activate the sperm. To conserve the sperms' energy, thus encourage activity and motility of the thawed sperm, it was important to freeze the sample quickly after adding the sperm to the cryoprotectant. Additionally, it was important to control the timing of the freezing cycle. Theilacker sent a "sperm-freezing kit" out on the *Jordan* to use with Dover sole collected on the groundfish cruise. Lynn will freeze and store the sperm of mature Dovers aboard ship to facilitate artificial reproduction studies at the SWFC aquarium.

CalCOFI 40th Anniversary Plans

As a member of the California Cooperative Oceanic Fisheries Investigations (CalCOFI) 40th Anniversary planning committee, Theilacker met at Scripps Institution of Oceanography (SIO) to discuss the content and format for a brochure on CalCOFI which will be included with the letter of invitation to the Anniversary Conference. The Conference will be held at SIO on October 25-27, 1989 and will be combined with a public open house at SIO and at SWFC to celebrate the 40th anniversary of CalCOFI and the 25th anniversary of the SWFC building. (G. Theilacker, FTS 893-7125)

Distribution and Abundance of Juvenile California Halibut

Biological Technician Sharon Kramer has completed a 2 year groundfish survey of southern California coastal lagoons and bays, and near shore coastal habitats. The first step in the analysis of these data was to determine the distribution and abundance of juvenile Califor-

nia halibut in shallow coastal waters and in Mission Bay and Agua Hedionda Lagoon, because halibut is the most important species in the near shore bay and coastal environment.

Kramer reports that she is completing a paper on the distribtion and abundance of juvenile California halibut *(Paralichthys californicus)* in southern California to be submitted to the California Department of Fish and Game Symposium on the California halibut.

The results were very different over the 2 years of the study. In 1987, peak settlement of halibut (SL <20 mm) occurred during the spring in very shallow (<1 m deep) bay habitats (Mission Bay and Agua Hedionda, Figure 2), and very few settled on the open coast (40 nm between San Onofre and Mission Bay). The greatest densities observed throughout the survey were obtained in the shallow shoreline habitats of the bays in the spring of 1987.

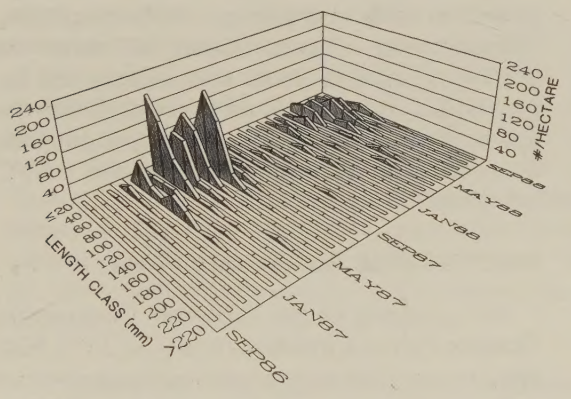


Figure 2. Density of California halibut in the shoreline habitat of the bays (depth <1 m). Density in number/hectare.

As juveniles grew, they moved into deeper bay habitats with movement from the bays to the open coast from 150-200 mm SL. Halibut reached this size within one year from settlement and moved offshore during the fall and winter of 1987 (Figure 3).

In contrast, in 1988 settlement occurred on the open coast during spring and summer (Figure 4). Settlement along the open coast occurred in shallow (<9 m) water. High densities of halibut were also found in the open water habitat of the bays, with very little settlement in the shoreline habitat (Figures 3 and 4). The total number of halibut settling in 1988 was much greater than that observed in 1987

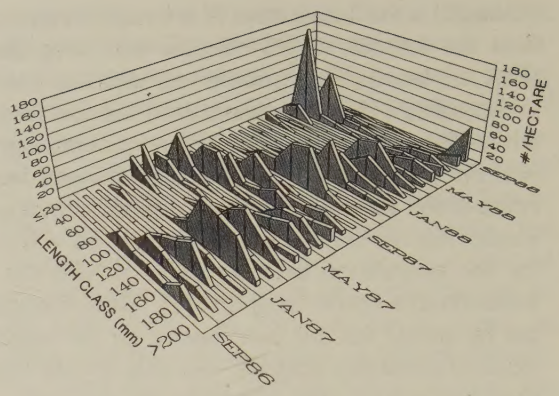


Figure 3. Density of California halibut in the open water habitat of the bays (depth 1-4 m). Density in number/hectare.

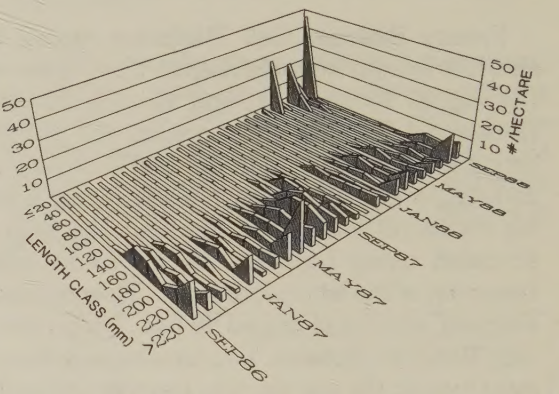


Figure 4. Density of California halibut along the open coast (depth <15 m). Density in number/hectare.

due to settlement on the open coast. Although settlement can also occur on the open coast, the primary nursery habitats appear to be the shallow bays because they have the greatest densities of juvenile halibut. (S. Kramer, FTS 893-7105)

SURVEY SYSTEMS DEVELOPMENT AND EVALUATION

Evaluation of the CDF&G Design of Port Sampling of the Wetfish Fishery

Under a cooperative agreement with the California Department of Fish and Game (CDF&G) (6C-2019, June 15, 1987-March 31, 1989) N.C.H. Lo and D. Mallicoate evaluated the port sampling procedure presently used by the California Department of Fish and Game (CDF&G) and a draft of the final report has been completed. The Southwest Fisheries Center (SWFC) has a common interest in the age and

species composition of the catch of the California wetfish fishery; CDF&G is responsible for sampling the landings, but both agencies use the data for stock assessment and research. The objectives and the initial analysis of the study were reported in the Bimonthly Report of Activities, January-February 1988.

Using age and species composition data collected in 1982 and 1986, Nancy Lo, Mathematical Statistician, developed a simulation procedure to evaluate the current estimation procedures. Cost analyses were carried out to evaluate the optimal sample allocation for age and species composition. The principle conclusions and recommendations were as follows:

Age Composition

Best estimates for age composition: Currently, age composition is sampled by taking 40 random samples per 5,000 tons of the total cumulated catch. The simulation results indicate that when the current age composition is expressed in terms of number of fish per gram, little bias exists for Pacific mackerel, but the bias is large for jack mackerel. If the number of fish per gram is weighted by the jack mackerel catch and adjusted by the total catch of the boat (hailed landing), bias is reduced. The type of ratio estimator used (number of fish per gram or number per sample, or either value with various weightings) did not effect the coefficient of variation (CV). The CV's differed among age groups, however, if a single ratio estimate is to be used for all species, then number of fish per gram weighted by catch is recommended in future age composition computation.

Minimum number of boats per stratum: The minimum number of samples (within a 5,000 ton strata) needed to sample the age composition of Pacific mackerel and jack mackerel varied with age. Thirty samples of Pacific mackerel within a stratum provides estimates with a CV. For 2 year old jack mackerel a sample size of 30 guarantees a CV <0.5, but for 1 year olds the sample size needs to be much larger; a sample of 50 provides an estimate with a CV <2.0 .

Comparison of sampling designs: Currently, the 40 samples within the 5,000 ton strata are allocated to boats according to the weight of their catch (PPS). An alternate approach is to sample the boats with equal probability (simple random sample with replacement (SRS)). The SRS provided ratio estimates of age composition with small relative bias, but the CV under SRS and PPS were similar. For Pacific mackerel, the current method (number of fish per gram, unweighted) is the least biased method under either design. For jack mackerel, the number of fish per gram weighted by catch and total landings of all species (PPS) was the preferred method for estimation of age composition. The current sampling procedure (PPS) is acceptable for all species if the ratio estimator is weighted by catch and total landings.

Sample allocation for age composition: At the most, two samples per boat are sufficient for Pacific mackerel, whereas for jack mackerel, no more than three samples per boat are necessary for most age groups. Thus, no more than three samples per boat for age composition are needed.

Species Composition

Comparison between visual estimate and bucket estimate: The following two methods have been used to evaluate species composition of the catch. An estimate based on a visual inspection of the catch and one based on actual counts of each species in a bucket sample. Visual estimates and bucket estimates of species composition were similar; differences between estimates were negligible. Thus, the visual method can continue to be used as the standard method for estimating species composition.

Minimum number of bucket samples per boat: A total of three bucket samples per boat is sufficient for estimating species composition. One or two samples are adequate if the cost of visiting a boat is more than 10 times that of processing a sample.

Effect of variance in species composition on variance of age composition: Variance of the estimate of species composition of the catch has a significant effect on the variance of age composition of any species. Thus, the variance of the species composition should be incorporated in the final computation of variance of age composition.

Deciding when a species is to be sampled: Currently, jack mackerel and Pacific mackerel are sampled when they comprise 5% of the total catch of all species, while sardines are sampled when they comprise only 1% of the total catch. Using this procedure 1% of the total catch

of jack mackerel and 1% of the total catch of Pacific mackerel are not sampled, but in sardines, 25% of the total catch is not sampled. If manpower is a problem and the species composition remains unchanged, the decision criterion for Pacific mackerel and jack mackerel could be raised from 5% to 10%. If raised to 10%, no more than 3% of the landing would go unsampled. (N. Lo, FTS 893-7123)

COMMERCIAL AND RECREATIONAL FISHERIES RESEARCH FOR MANAGEMENT

San Diego State University Students Serving as Interns in the Commercial and Recreational Fisheries Research for Management Program

Industry Economist, Sam Herrick reports that Sarah Barnes and Tony Applebaum, both senior economics majors at San Diego State University (SDSU), have started student internships in the Commercial and Recreational Fisheries Research for Management Program at the Southwest Fisheries Center. The SDSU Internship Program offers SDSU undergraduate economics majors an opportunity to acquire valuable work experience that will assist them in future career planning. They earn course credits upon successful completion of the Program.

The student interns serve as volunteers, working under the direction of Southwest Fisheries Center personnel on a specific research project. Barnes will be working under the direction of Dr. Daniel Huppert, Leader of the Commercial and Recreational Fisheries Research for Management Program, on a research project that will review and update the status and economic importance of groundfish, salmon, pink shrimp, Dungeness crab and albacore tuna fisheries occurring off the west coast. This work will entail compiling and analyzing data from a number of sources in order to identify trends and events that have affected the performance of these fisheries in recent years.

Applebaum will be working with Herrick on an investigation of recent trends and economic conditions in world and U.S. tuna fisheries. Part of this work will involve a time series analysis of historical tuna landings, exvessel price, processing and consumption data sets in order to develop extrapolation models for these economic variables. The results of this investigation will provide National Marine Fisheries Service managers with useful information for evaluating alternative management strategies for Pacific and Indian Ocean tuna fisheries. (S. Herrick, FTS 893-7111)

Strategies for Recreation Demand Model Building

Cindy Thomson, Industry Economist, has written a paper entitled "A general strategy for building recreation demand models." The paper describes the purpose and underlying assumptions of classical statistical test procedures that are used to evaluate alternative model specifications. Some of the important concepts in this regard are the distinction between nested and non-nested models, between tests of specification and tests of misspecification, and between general and specific tests. The paper discusses the derivation of tests pertaining to nested hypotheses, such as the likelihood ratio test, the Wald test and the Lagrange multiplier test. The paper also covers tests relevant to non-nested hypotheses, such as artificial nesting procedures and the generalized likelihood ratio test. Thomson also briefly describes some non-Bayesian decision rules for discriminating among models, some of which are *ad hoc* in nature and others which are based on information theory. She illustrates the various concepts with examples from the recreation demand literature.

Finally, Thomson suggests a more orderly strategy for model building than the inefficient *ad hoc* approach that is often taken. This strategy can be summarized as follows:

1. Construct a general model that incorporates all available prior information regarding functional form, explanatory variables, and other model characteristics. Because economic theory has little to say about many aspects of model specification, the analyst will probably be able to identify more than one general model that is consistent with theory.

2. Evaluate the adequacy of the data. This involves determining (a) whether data on the variables identified in Step 1 are available, (b) whether there is sufficient variation in the data to capture the relationships hypothesized in Step 1, and (c) whether the sample sizes are sufficiently large so that the parameters can be estimated with confidence.

3. Estimate the model(s) and perform specification tests. The categorization of statisti-

cal tests discussed earlier in the paper is useful at this stage for determining which tests are appropriate for testing which hypotheses.

4. In the course of conducting specification tests in Step 3, the analyst may become aware of shortcomings in the model(s) devised in Step 1. Tests of misspecification may be warranted at this stage. Because misspecification can take a variety of forms, a battery of such tests should probably be performed. A model may be rejected on the basis of some tests but not others since a misspecified model can possess some characteristics of the true model.

5. Use of the sample data for model selection as well as parameter estimation leaves the analyst open to the charge of "data mining." For this reason, it is important to do some post- sample predictive testing. This is a more critical test of the model than a within-sample measure of goodness-of-fit. The results of post-sample tests may lead the analyst to consider new model specifications and go through yet another round of specification and perhaps misspecification tests. To the extent that this occurs, post-sample testing no longer provides an independent assessment of model adequacy but becomes a part of the model specification process itself.

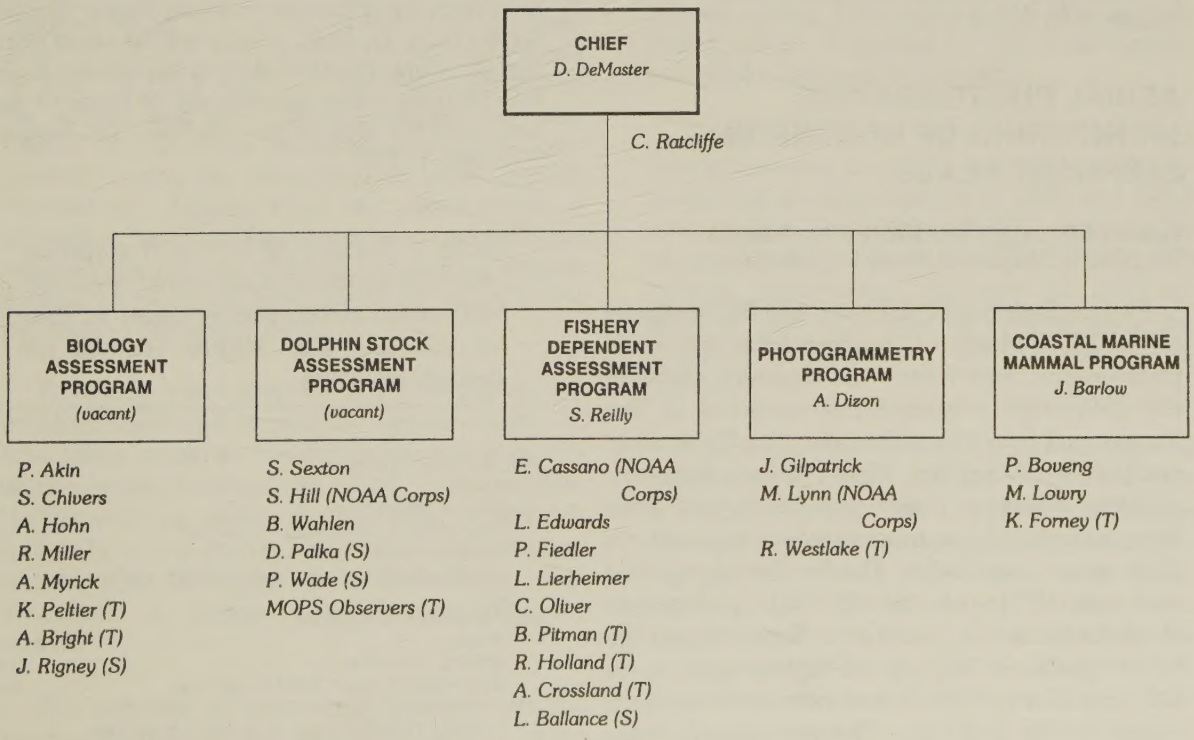
The procedures laid out in Steps 1-5 should be viewed as guidelines for model-building rather than "hard and fast" rules. Even as guidelines they can be difficult to follow given the inadequacies often present in recreational fishing data and the minimal guidance provided by theory with regards to model specification. Regardless of the problems encountered in empirical work, it is still useful to have an overall strategy towards which to work. (C. Thomson, FTS 893-7116)

FISHERY-MARINE MAMMAL INTERACTIONS DIVISION

La Jolla, California

Reorganization of Fishery-Marine Mammal Interactions Division

With the loss of Dr. Rennie Holt, Operations Research Analyst, to the Southwest Fisheries Center's Antarctic Ecosystem Research Group and Peter Boveng, Operations Research Analyst, to the National Marine Mammal Laboratory, the Fishery-Marine Mammal Interactions Division



(FMMID) has had to make a few adjustments. Prior to the reorganization, the Division was made up of three programs: 1) the Fishery Independent Assessment Program that dealt with the research vessel cruises in the eastern tropical Pacific (ETP) and coastal marine mammal assessments; 2) the Fishery Dependent Assessment Program that dealt with tuna vessel observer data (TVOD) and ETP ecosystem research; and 3) the Biological Assessment Program that dealt with the interpretation of life history patterns in ETP dolphins and stock identification. Under the new reorganization, the Division will now have five programs. The Biological Assessment Program and the Fishery Dependent Assessment Program remain unchanged. The Fishery Independent Assessment Program has been divided into three new programs--Dolphin Stock Assessment Program, Photogrammetry Program, and the Coastal Marine Mammal Program. Dr. Andrew Dizon, the former Leader of the Biological Assessment Program will now be in charge of the Photogrammetry Program and Dr. Jay Barlow will be leading the Coastal Marine Mammal Program. Dr. Douglas DeMaster, Chief of the Fishery-Marine Mammal Interactions Division will be acting head of the remaining two programs until program leaders can be hired. A summary of the new organization is shown in Figure 1. It is hoped that the new division will allow people outside of the Center to more easily follow the research activities and publications of specific research teams. (D. DeMaster, FTS 893-7165)

AERIAL PHOTOGRAPHIC MONITORING OF NORTHERN ELEPHANT SEALS

Aerial Surveys Conducted to Assess Northern Elephant Seal Population

Fishery Biologist Mark Lowry and NOAA Corps officer LTJG Morgan Lynn completed two aerial photographic flights over the northern elephant seal (*Mirounga angustirostris*) rookeries at San Nicolas and San Miguel Islands. The flights were conducted during the 1989 January-February breeding season to obtain pup counts and other information for future assessments of the northern elephant seal population. The first flight was made on January 28 to coincide with the largest number of adults hauled out on the rookeries during the breeding season. The second flight was made on February 16 when the highest number of pups are found on the rookeries. The photographs were taken from a twin engine Partenavia equipped with a glass nose and a camera port located in the fuselage. All photographic passes of the rookeries were made at an altitude of 800-900 feet. Two KA-45, 5-inch format cameras were used: one containing color film and the other black-and-white film.

From the photographs taken during the two flights it will be possible to (1) obtain counts of pups and adults, (2) estimate lengths of individuals, (3) calculate surface area of the breeding beaches to determine density, and (4) study spacing behavior from estimated distances between individuals. The color photographs will be used to count the seals, and because of its finer grain the black-and-white photographs will be used for measurements. Length, area, and spacing distances are estimated from the photographs using fixed objects in the photographs as scale. These objects include targets placed on the ground at a known distance prior to the flights and natural objects (rocks, logs, etc.) on the rookery which will be measured later. A Zeiss Planicomp analytical stereo plotter, made available to the SWFC by an engineering firm in San Diego, will then be used to estimate lengths of many individuals, surface area, and distances between individuals.

Thus far only one count of all northern elephant seals has been completed for each island from the photographs taken during the first flight (Table 1). Next, counts will be made from the photographs taken during the second flight and then the measurements will be made of the seals and the area of the beaches. (M. Lowry, FTS 893-7174)

Table 1. Counts of northern elephant seals (*Mirounga angustirostris*) obtained from aerial photographs taken at San Nicolas and San Miguel Islands on January 28, 1989.

San Miguel Island:	
Pups	10,092
Adult females	10,444
Sub-adult and adult males	1,668
Juveniles	21
Adult females or sub-adult males	7
San Nicolas Island:	
Pups	4,123
Adult females	4,310
Sub-adult and adult males	549
Juveniles	16
Adult females or sub-adult males	3

Dolphin Stock Assessment Program

Report Prepared on First 2 Years of MOPS Cruises for Annual Report to Congress

The SWFC is responsible for detecting trends in the relative abundance of those dolphin stocks taken incidentally by tuna purse seiners in the eastern tropical Pacific (ETP). The status of the spotted dolphin, *Stenella attenuata*, is of special concern because it is the major species taken by the fishery. Of the several stocks of spotted dolphins in the ETP, the northern offshore stock is considered to be the most affected by the fishery because it has been fished more frequently than any other stock. Other species involved in the fishery include spinner (*S. longirostris*), striped (*S. coeruleoalba*), common (*Delphinus delphis*) and Fraser's (*Lagenodelphis hosei*) dolphins. In the abundance analyses discussed below, these five species are often grouped and termed target species. Also, "abundance estimate" refers to a relative abundance index. At this time, we are not prepared to equate our abundance estimate, based exclusively on research vessel data, with estimates of absolute abundance.

In 1986, the SWFC initiated a research program to monitor relative abundance of dolphin populations in the ETP using two research vessels for at least 5 years during which six surveys will be conducted. The research design for the surveys (using line transect methodology) indicated that a 10% annual rate of decrease in northern offshore spotted dolphins could be detected (a total 41% decrease over six surveys) with alpha and beta error levels of 10%. In 1987 and 1988, the SWFC conducted the second and third surveys utilizing the same vessels (NOAA Ships *McArthur* and *David Starr Jordan*) during the same seasons (July through December). During these last two surveys, a helicopter, based off the *Jordan*, was used to obtain vertical photographs of dolphin schools. Analyses to date include data from the first 2 years of the program (1986 and 1987).

The study area within the ETP was partitioned into four strata: inshore, middle, west and south. All four strata comprise the total area; northern offshore spotted dolphins are found in the inshore, middle and west strata. During 1986, 43, 28, 14, and 15% of the survey effort was in the inshore, middle, west and south strata, respectively. The allocation of survey effort during 1987 was similar.

The estimates of abundance for northern offshore spotted dolphins during 1986 and 1987 were not statistically different ($p > 0.01$). The 1986 and 1987 estimates were 929,000 and 1,275,400 animals, respectively. The 1987 estimate was larger than the 1986 estimate because of increases in estimates of school density in all strata. The 1986 estimates for density in the inshore, middle, and west strata were 3.62, 2.56, and 1.89 schools/1000 km^2, respectively; the corresponding 1987 estimates were 4.74, 3.15, and 2.16 schools/1000 km^2, respectively. In addition, the proportion of spotted dolphins in the target species increased in the middle stratum (0.378 in 1986 to 0.524 in 1987). However, the proportion of all dolphins that were target species in the middle stratum slightly decreased from 0.906 in 1986 to 0.858 in 1987.

The observed increases in abundance between 1986 and 1987 occurred in spite of a decrease in school size in the inshore and west strata. Estimates during 1986 in the inshore, middle, and west strata were 89.41, 83.97, and 104.55 animals, respectively. Corresponding estimates of school size during 1987 were 81.57, 84.56, and 94.12, animals, respectively.

Abundance estimates for the southern stocks of the target species varied significantly between 1986 and 1987. This variability was because estimates in the south stratum were based upon few sightings. For example, the estimate for southern common dolphins was 943,200 animals during 1986 but was 201,000 animals during 1987. Estimates for the other species exhibited corresponding changes.

Whereas estimates for some stocks varied greatly between years, the total abundance estimates for all target species in 1986 and 1987 were similar. The 1986 and 1987 estimates for all target species were 4,471,200 and 5,185,600 animals, respectively. Although the 1987 estimate is 16% larger than the 1986 estimate, the observed difference is not statistically significant.

The reason for the larger 1987 abundance estimate for northern offshore spotted dolphins is attributed at this time to sampling variability between surveys. Various methods of calculating the abundance index have been investigated. Several factors which may have contributed to differences observed between the surveys are still being explored. These include ship effects, observer variability, sea state effects and survey coverage variability. Selection of the

best option to determine population changes will be examined with additional years' data. (S. Sexton, FTS 893-7097)

FISHERY DEPENDENT ASSESSMENT PROGRAM

Workshop Held on Estimating ETP Dolphin Mortality

On January 30-31, 1989, a workshop was held at the Southwest Fisheries Center, La Jolla, to review results of three studies relating to the estimation of annual mortality rates for stocks of dolphins killed during purse seine fishing in the eastern tropical Pacific (ETP). Twenty people participated in the workshop, representing the Southwest Fisheries Center, Southwest Region, Marine Mammal Commission, Inter-American Tropical Tuna Commission, Center for Environmental Education, Greenpeace, American Tunaboat Association, Porpoise Rescue Foundation and the Government Accounting Office. The meeting was convened and chaired by Dr. Steve Reilly, Fishery Biologist.

NOAA Fisheries is responsible for monitoring dolphin mortality on a within-year, nearly real time basis, to determine if or when numerical mortality quotas are reached or exceeded. Under the Marine Mammal Protection Act of 1972 (amended every 4 years since) the purse seine fishery on dolphins must cease for the year when mortality quotas are exceeded. The meeting was called to present and review technical and scientific manuscripts and did not delve deeply into the areas of agency policy, management or enforcement. The workshop considered refinements of existing, established methods. The titles, authors and abstracts of the papers reviewed are:

Atilio L. Coan, Kenneth E. Wallace and Alan R. Jackson. Comparisons of dolphin mortality rates between day and night sets. SWFC Admin. Rep., La Jolla, LJ-88-29.

Information collected by NMFS and IATTC observers aboard US tuna purse seiners fishing in the eastern tropical Pacific was analyzed to see if differences occurred in dolphin mortality rates between net sets made during the day and during the night. We investigated possible differences in mortality rates resulting from use of high-intensity flood lights, from placing curfews on night sets, and from including seriously injured animals in the mortality statistics. Results indicated that dolphin mortality rates in night sets were two to seven times greater, and are statistically different from mortality rates in sets made during the day. Inclusion of seriously injured animals did not change the differences between day and night mortality rates. Mortality rates were lower by as much as 70% in night sets where high-intensity flood lights were used, as compared to sets where other types of lights were used. Even when high-intensity lights were used, night set mortality rates were still significantly higher than day set mortality rates. The use of curfews could reduce night set mortality by as much as 85%. Further reductions in mortality could be realized if methods can be found to eliminate problems associated with a relatively few high mortality sets.

Elizabeth F. Edwards, Bruce E. Wahlen and Christina Perrin. Effects of percent coverage on estimates of cumulative mortality: results from subsampling the 1987 data base. SWFC Admin. Rep., La Jolla, LJ-89-05.

During 1987, scientific observers monitoring dolphin mortality accompanied nearly 100% of all US purse-seine vessels involved in the eastern tropical Pacific tuna-dolphin fishery during 1987. The effect on cumulative estimates of dolphin mortality of lower percent coverages of the tuna-dolphin fleet was investigated by simulating coverages of 25, 33, 50, 75, and 96% during this year of nearly complete coverage. Each percent coverage was simulated 500 and 1000 times, maintaining the temporal structure of the original data set by drawing randomly from each month P% of the trips active during that month. Mean estimates of cumulative mortality, the relative bias of these estimates, and their coefficients of variation were derived from each set of replicate samples, for 8 groups of dolphins. These groups were 1) total (all species and stocks combined), 2) northern offshore spotted dolphins, 3) whitebelly spinner dolphins, 4) eastern spinner dolphins, 5) unidentified spinner dolphins, 6) common dolphins, 7) striped dolphins, and 8) other dolphins (dolphins not assigned to groups 2-7). Analytic estimates of cumulative mortality, relative bias and coefficients of variation were derived for each of the percent coverages. Bootstrapped estimates were derived for 33% coverage, basing the bootstrap estimates on the same 500 samples used to derive the analytic estimates at 33% coverage. We found that es-

timates of cumulative monthly mortality, averaged over 500 or 1000 replicate subsamples at each percent coverage, were very accurate at all 5 coverages (relative bias of the mortality estimates ranged from about -1% to +3%). Coefficients of variation were much more sensitive to data accumulation, decreasing strongly with increased percent coverage and (less strongly) with increased time and increased numbers of dolphins. With 96% coverage, CVs decreased to less than 10% by the end of the year for all groups. With only 25% coverage, however, coefficients of variation ranged from 30-50% for the more abundant groups (total, northern offshore spotted dolphins, whitebelly spinner dolphins, eastern spinner dolphins), to about 110-150% for the less abundant groups (common dolphins, unidentified spinner dolphins, striped dolphins, and other dolphins). Simulation results were affected only marginally (usually less than +/- 1%) by increasing replication strength from 500 to 1000 samples at each percent coverage, or by bootstrapping estimates rather then calculating analytical estimates.

C. W. Oliver and E. F. Edwards. Effects of including dolphins seriously injured and of unknown status in mortality estimates. SWFC Admin. Rep., La Jolla, LJ-89-04.

Observers have accompanied a sample of US tuna purse seine vessels fishing in the eastern tropical Pacific since the late 1960s. The number, sex, age-class and species of dolphins killed during the fishing operations have been recorded and subsequently used to estimate annual mortality. Observers also tally additional categories describing an animal's condition at the time of release from the net. In this study we describe the frequency of occurrence of animals categorized as either seriously injured, status unknown, or both for the period 1975-1988. We investigated the effects on annual mortality rates of including some or all of the animals recorded as seriously injured or of unknown status. Including all animals recorded as seriously injured would have increased annual mortality rates by an average of 4.2% for the entire period 1975-1988, but by just 1.8% for years since 1981. Including status unknown animals would have increased annual mortality rates by an additional 2.7% a year, on average, for 1975-1988, and 1.6% since 1981. The occurrence and magnitude of these additional tallies varied between species and years.

The results of the workshop are being summarized into a SWFC Administrative Report. The authors are now revising their manuscripts following input given to them at the meeting and in writing. (S. Reilly, FTS 893-7164).

PHOTOGRAMMETRY PROGRAM

Photographed Cetacean Schools Counted

To date, approximately 40% of the cetacean schools, photographed by team members of the Photogrammetry Program during the 1988 dolphin surveys, have been counted. As reported in the Bimonthly Report of Activities, November-December 1988, the goal of the program is to photograph schools of dolphins, make accurate counts of the number of individuals within the school, and to use these counts to "calibrate" the estimates made by the ship-based observers. Obviously, estimates of abundance of the various populations of eastern tropical Pacific dolphins that are killed by the yellowfin tuna fleet are critically dependent on accurate estimates of schools size.

Total helicopter sampling and effort for both field seasons, 1987 and 1988, are summarized in Table 2 in more detail than in the last report. The table, compiled by LTJG Morgan Lynn (NOAA Corps and one of the team members) include data on days flown, days lost to bad weather (wind speed above about 12 mph or bad visibility), percent days flown, flight hours, and average flight hours per day flown.

During the hours flown, the team members photographed 185 schools in the two field seasons, 106 of them were or will be counted and will be used to calibrate the estimates made by the observers. While 159.1 hours were flown in 1987, only 133.8 were flown in 1988 due to bad weather during leg 1. However, greater experience of knowing when conditions will allow countable photographs to be taken, allowed us to be more efficient: 73% of the schools photographed yielded countable schools in 1988, where only 47% of them did in 1987. Twenty-nine other schools were counted; these were primarily large cetaceans in small schools where the counts are very accurate and no calibration is necessary. The photographic data will also be used for making length estimates and

Table 2. Helicopter sampling and effort summary 1987-1988.

Leg no.	Days flown	Days lost	% Days Flight flown	hours	Average flight hours per day flown	No. schools photographed for calibration experiment	No. other schools photographed	No. schools actually used for calibration	S. atten	S. long	Mixed school atten & long	S. coer	D. delph	Other small cetacean	Unid. small cetacean	Small cetacean leg totals	Large whales	Beaked whales	Small whales
1987																			
1	12	9	57%	36.4	3.03	24	1	11 (46%)	7	4	3	2	4	4	1	25	0	0	1
2	12	16	43%	28.5	2.38	38	5	19 (50%)	10	2	5	7	4	7	0	35	1	4	6
3	15	11	58%	47.7	3.18	28	9	15 (54%)	4	1	2	11	2	7	0	27	3	6	1
4	16	12	57%	46.5	2.91	24	1	9 (38%)	4	3	3	8	0	3	0	21	2	0	1
SUBTOTAL	55	48	54%	159.1	2.88	114	16	54 (47%)	25	10	13	28	10	21	1	108	6	10	9
1988																			
1	7	22	24%	11	1.58	8	1	7 (88%)	0	2	0	3	0	3	0	8	1	0	0
2	12	17	41%	34	2.83	20	0	12 (60%)	0	0	0	7	6	7	0	20	0	0	0
3	17	12	59%	46	2.71	25	7	19 (76%)	1	0	4	17	3	0	1	26	0	3	3
4	14	15	48%	42.8	3.06	18	5	14 (78%)	1	5	3	12	3	5	0	19	3	1	0
SUBTOTAL	50	66	43%	133.8	2.54	71	13	52 (76%)	2	7	7	29	12	15	1	73	4	4	3
TOTAL	105	114	49%	292.9	1.45	185	29	106 (62%)	27	17	20	57	22	36	2	181	10	14	12

collecting various data on their reproductive biology. (A. Dizon, FTS 893-7089)

HONOLULU LABORATORY

Honolulu, Hawaii

PELAGIC RESOURCES INVESTIGATION

Research Cruise Studies New Longline Gear

Experiments with the new monofilament fishing gear used by the longline fishery in Hawaii were conducted during a research cruise east of the island of Hawaii in January 1989 by Honolulu Laboratory personnel on board the NOAA Ship *Townsend Cromwell*, according to Christofer H. Boggs, Leader of the Pelagic Ecosystem Program. The new longline gear is more flexible than traditional gear in its configuration and the depths it can fish. Monofilament longline gear is becoming popular in Hawaii's rapidly expanding commercial tuna longline fishery. Each time a major change occurs in the type of gear used by longline fishermen, the efficiency of the gear at catching each species is altered and the by-catch of non-target species changes. To understand how these changes affect catch rates independently from true changes in the abundance of fish, scientists need to know how the use of monofilament longline gear affects the catch rates for target species and by-catch.

As longline gear is set and pulled, it moves through a variety of depths, temperatures, and dissolved oxygen concentrations. Fish may bite at any point during this process. During the research cruise, microcomputer time-depth recorders attached to the longline gear documented the depths at which the gear was fished. Electronic hook timers attached to the baited leader lines determined when individual fish struck the hooks. To determine the characteristics of the depths at which fish were caught, scientists used expendable bathythermographs to measure temperature at depth, conductivity-temperature-depth probes to measure temperature and salinity, and bottle casts to measure dissolved oxygen at depth.

During the study, billfishes made up the majority of the catch in sets shallower than 100 fathoms; bigeye tuna, *Thunnus obesus*, made up a greater proportion of the catch in sets deeper than 150 fathoms. The major target species of longline fishermen in Hawaii are ahi, *Thunnus* spp.--especially bigeye tuna, which bring the highest price. Studies, primarily by scientists in Japan, indicate that these are deep-swimming tuna, with a temperature preference between 10° and 15°C. These temperatures are generally found at depths of 100 to 200 fathoms in

Hawaiian waters. Other *Thunnus* spp. and billfishes prefer warmer temperatures and shallower depths.

Scientists found that it was more difficult to set the gear at deep depths than at shallow depths, even when sea conditions were optimum. Sometimes the current shear between the surface and waters below the thermocline, observed on the *Townsend Cromwell*'s acoustic Doppler current profiler, prevented the achievement of a deep set. Deep sets also took longer to retrieve than did shallow sets. The results of the study indicate that, as commercial longliners gain experience in the use of the new monofilament fishing gear and acquire more knowledge of the current structure around Hawaii, the catch of target species may be increased and the by-catch reduced.

Five-Year Research Plan for Tunas Completed

A 5-year research plan for modeling and predicting distribution, abundance, and movements of tunas was completed in February 1989 by Richard W. Brill, Fishery Biologist; Jerry A. Wetherall, Leader of the Pelagic Resources Investigation; and Christofer H. Boggs, Leader of the Pelagic Ecosystem Program. The plan, "Use of Environmental Data and Biological Models to Improve Tuna Stock Assessments and Yield Forecasts," describes two projects on tuna habitat modeling. One project is aimed at improving assessments of yellowfin tuna, *Thunnus albacares*, stocks in the eastern tropical Pacific by the end of fiscal year 1990. The other proposes to develop predictive models of yellowfin tuna and bigeye tuna relative abundances in the central Pacific by the end of fiscal year 1993.

Improving models for tuna stock assessment and catch prediction by broadening them to include information on tuna physiology and environment is a main objective of the Pelagic Ecosystem Program. Among its several research tasks, the Program conducts basic research on the physiology and behavior of tunas as a function of physiological capacities and environmental parameters. (R. Brill (808) 943-1221)

Experiments on the Effect of Temperature on Blood Acid-Base Balance in Yellowfin Tuna Completed

Experiments designed to elucidate the effect of temperature on blood acid-base status in yellowfin tuna were recently completed by Fishery Biologist Richard W. Brill, working in conjunction with Peter G. Bushnell, a postdoctoral fellow at the University of Columbia, and David R. Jones, a visiting scientist with the Department of Zoology, University of British Columbia. The experiments involved study of whole animals and isolated blood. The research is part of a larger effort designed to measure low ambient oxygen tolerance of tunas at the reduced temperatures (15°-20°C) where these low ambient oxygen levels are encountered, and to eventually predict tuna movements and distribution in relation to environmental parameters. (R. Brill (808) 943-1221)

New Technique Measures Ventilation Volume in Tunas

A continuous infusion dye-dilution technique has been developed and found to be suitable for direct measurement of ventilation volume (V_g) in swimming fish, according to Fishery Biologist Richard W. Brill. The technique successfully measured ventilation volume in swimming kawakawa, *Euthynnus affinis*; yellowfin tuna, *Thunnus albacares*; and skipjack tuna, *Katsuwonus pelamis*. The highest ventilation volume recorded was 6.05 $L \cdot kg^{-1} \cdot minute^{-1}$ in a yellowfin tuna (mass = 1.075 kg) swimming at 2.29 body lengths (BL)$\cdot second^{-1}$, and the lowest was 1.40 $L \cdot kg^{-1} \cdot minute^{-1}$ in a kawakawa (mass = 1.375 kg) swimming at 1.15 $BL \cdot second^{-1}$. At low swimming speeds ($BL \cdot second^{-1}$), ventilation volume ranged from 1.4 to 2.0 $L \cdot kg^{-1} \cdot minute^{-1}$, somewhat lower than has been generally assumed for tunas. Oxygen consumption at these swimming speeds ranged from 302 to 555 $ml \cdot kg^{-1} \cdot hour^{-1}$.

The first direct measurements of ventilation volume in restrained fish were obtained in 1938 by using a rubber membrane, which was stretched around the fish's head, to separate inspired and expired water. In the ensuing 50 years, modifications to this technique have been widely applied in studies of fish physiology. However, current methods for measurement of ventilation volume in swimming fish are indirect and require accurate determination of inspired (P_{IO2}) and expired (P_{EO2}) oxygen tensions and of oxygen consumption (V_{O2}). While inspired oxygen tensions can be easily determined, measurement of expired oxygen tensions can be troublesome, and for fish swimming in a large volume of open water, establishing oxygen consumption is next to impossible. A new method was therefore required to measure ventilation volume in swimming tunas.

Since many fish ram ventilate at high swimming speeds, this new dye-dilution technique may also prove suitable for measuring ventilation volume in other species. The new technique is described in "Measurement of ventilation volume in swimming tunas," by David R. Jones, Richard W. Brill, Patrick J. Butler, Peter G. Bushnell, and Mark R. A. Heieis, which has been accepted for publication by the Journal of Experimental Biology. (R. Brill (808) 943-1221)

INSULAR RESOURCES INVESTIGATION

Status of the Lobster Stocks Completed

The fourth annual status of the lobster stocks in the Northwestern Hawaiian Islands (NWHI) was completed in January 1989 by Jeffrey J. Polovina, Leader of the Insular Resources Investigation, and Robert B. Moffitt, Fishery Biologist. The commercial logbook catch and effort data from 1983 to 1988 were used to estimate the maximum sustainable yield for the combined slipper lobster, *Scyllarides squammosus*, and spiny lobster, *Panulirus marginatus*, stocks at 1,140,000 lobsters, with a fishing effort of 848,000 trap hauls. The 1988 landings and effort fell within the confidence intervals for these estimates. A forecast curve for 1989 landings as a function of effort was estimated as well (Figure 1).

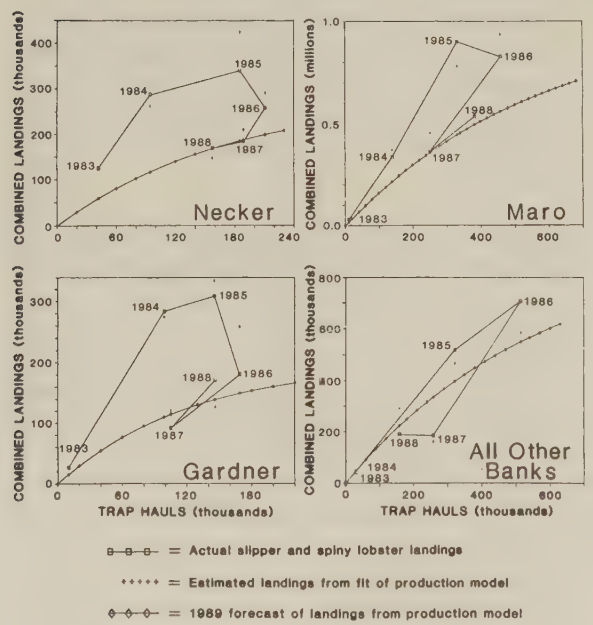


Figure 1. The actual, estimated, and 1989 forecast for NWHI spiny and slipper lobsters, by trap hauls, at Necker Island, Maro Reef, Gardner Pinnacles, and all other banks combined in 1983-88.

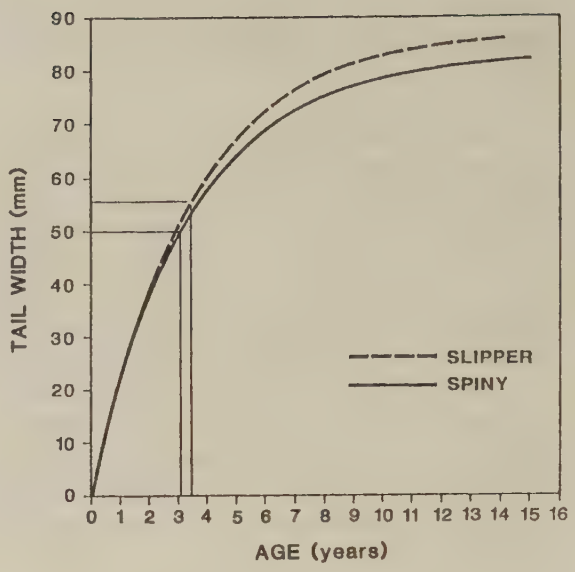


Figure 2. Growth curves for slipper and spiny lobsters at Necker Island after larval settlement. Spiny and slipper lobsters' minimum tail widths are 50 and 56 mm, respectively.

Based on the research data, adequate spawning stock biomass is being protected by the minimum sizes and escape vents at the current level of fishing effort. Growth curves derived from tail width frequency data collected from 1986 to 1988 research cruises at Necker Island estimate that spiny and slipper lobsters attain their minimum legal tail widths of 50 and 56 mm at 3.1 and 3.3 years, respectively, after larval settlement (Figure 2). (J. Polovina (808) 943-1218)

FISHERY MANAGEMENT RESEARCH PROGRAM

Action at the Auction

Volume at the Honolulu fish auction rose to new levels at the end of 1988, according to Biological Technician Kurt E. Kawamoto and Student Assistant Michael K. Hiu. Transactions lasted approximately 5 hours each morning in early December 1988 and then increased to 7 hours-per-day during December 19-31, with the auction beginning at 4:00 a.m., 1.5 hours earlier than normal. Landings of bigeye and yellowfin tunas increased substantially, but the prices did

not increase as much as in previous years. The fleet of longline tuna vessels off-loading increased substantially in 1988, and catch rates appeared higher than in 1987. Prices of bottom fish increased, but their supply was less elastic than that of tuna. Many of the former NWHI bottom fish vessels are now longlining for tuna.

Despite the auction's long hours and the large amount of tuna sold (about 30% more than in 1987), action at the auction did not appear as hectic as in 1987, when there was a stronger presence of Japanese export buyers (high-grade bigeye tuna are now shipped directly to Japan by fishing vessel operators). The highest prices were for bigeye tuna, which reached $17.50 per pound (round weight). Bottom fish such as opakapaka, *Pristipomoides filamentosus*, reached $8.00 per pound while onaga, *Etelis coruscans*, reached $12.00 per pound. (S. Pooley (808) 943-1216)

Linear Programming Model of NWHI Bottom Fish Fishery

Laurel D. Kasaoka, Cooperative Researcher with the Western Pacific Regional Fishery Management Council (Council), completed the "Linear programming model for the Northwestern Hawaiian Islands bottomfish fishery" (SWFC Admin. Rep., Honolulu, H-89-2C) in January 1989. The report presents the results of modifications to an existing mathematical model of Hawaii's commercial fisheries and describes the various components of the model.

The revised model incorporates new data on the economic benefits of a number of alternative fishery management regimes. The model runs on a Lotus 1-2-3 spreadsheet, using a propriety linear programming software package. The model will be utilized in the Honolulu Laboratory's economic research over the forthcoming year.

Kasaoka's report completes a year-long project funded primarily by the Council and secondarily by the Laboratory. (S. Pooley (808) 943-1216)

Preliminary Results on 1988 Lobster Fishery

Fishing activity (number of trips, 28; number of vessels, 9) in the NWHI lobster fishery in 1988 was lower than in 1987, but the number of trap-nights fished (845,000) remained approximately the same. Total landings of spiny lobster grew substantially in 1988 to 889,000 lobsters while landings of slipper lobsters declined to 168,600 legal lobsters. Catch per unit effort for legal spiny lobsters more than doubled in 1988 at 1.05 lobsters per trap hauled. Total catch rates for slipper lobsters declined somewhat.

Trips in the fall were reported to be of mixed success. Fishing was good until strong early winter storms caused significant damage to gear. Four vessels are expected to fish throughout the winter. Several vessels converted to tuna longline fishing but are planning to return to lobster fishing in the spring. (R. Clarke (808) 943-1213)

Billfish Controversy in Hawaii's Domestic Fishery

The Honolulu news media has displayed considerable interest in Hawaii's fisheries in recent months, with local television news programs and newspapers featuring several disputes: One concerning transshipment of tuna caught by Japanese longline fishing vessels, another between the recreational sportfishers and commercial tuna longliners over billfish by-catch, and a third dispute between local seafood wholesalers and the Honolulu fish auction over the direct shipment of bigeye tuna to Japan.

These central issues were aired during a "fishermen's forum" at the February 1989 meeting of the Council. In brief, the disputes center on allocation of Hawaii's tuna and billfish at both the fishery and market levels.

The transshipment issue involves a small local company that discovered revisions to the Magnuson Act allowing fish caught by foreign fishing vessels outside the 200-mile Exclusive Economic Zone to be transshipped onto a U.S. shuttle craft just outside the 3-mile territorial sea. Although U.S. Customs officials have not yet issued a formal ruling, fresh bigeye tuna apparently are considered normal waterborne cargo, not subject to the Magnuson Act, and not limited by U.S. coastwide shipping laws. The U.S. Department of State ruled that since the cargo was tuna, it was not considered "fish" and thus not covered by the Magnuson Act. Catches from the Japanese longline tuna vessels were off-loaded by the U.S. shuttle craft at Honolulu Harbor and flown to Japan. Some of the fish remained in the Hawaii market. Nine transshipments totaling approximately 135,000 pounds were made from December 1988 to January 1989, before operations were suspended as the result of protests by local fishermen. Local tuna longline fishermen complained that this operation placed increased

foreign fishing pressure on Hawaii's tuna stocks and would diminish their export and local markets.

The complaint by recreational sportfishers concerned the potential impact on billfish stocks by the dramatic increase in domestic commercial longline fishing activity around Hawaii. Unfortunately, hard data on the extent of this increase are not available, but increased longline tuna landings of at least 50% over the past 2 years are believed to be conservative estimates. Although longline vessels target high-valued bigeye tuna, they have had substantial catches of striped marlin, *Tetrapturus audax*, and higher incidental catches of blue marlin, *Makaira mazara*, the most prized sportfishing species. The biological impact of these catches is not known, nor is the extent of the direct interaction between the longline and sportfish fisheries.

Figure 3 gives a preliminary picture of pelagic species composition of landings, by gear type, in

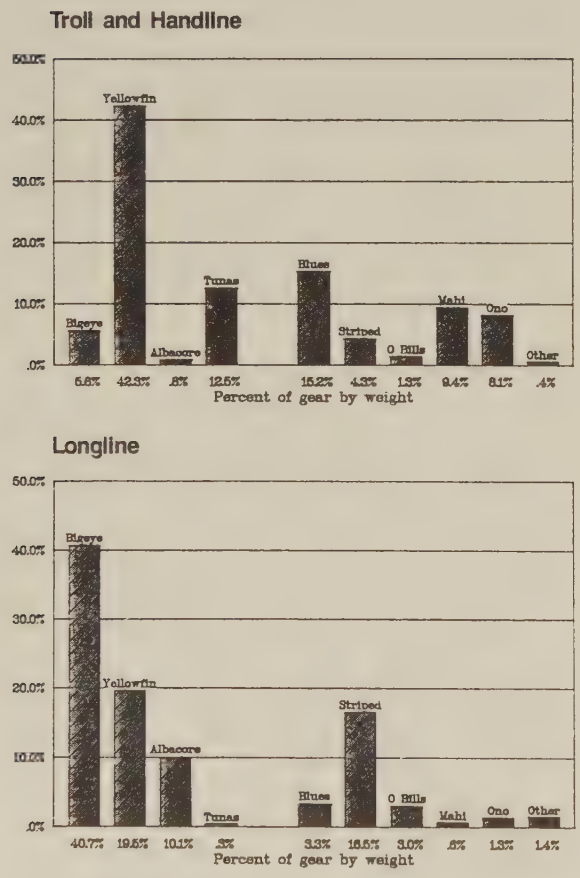


Figure 3. Percentage of landings by gear of pelagic fishes in Hawaii in 1988. "Tunas" = all tuna species except bigeye and yellowfin tunas, "0 bills" = all other billfishes (e.g., marlins and spearfish), and "other" = all other pelagic species.

Hawaii in 1988. This figure along with others was provided to the Council in hopes of shedding some light on the currently sensitive issue of by-catch. Users of this information should note that the data come from a sample of Hawaii's wholesale market. It is premature to make quantitative comparisons between gear types for 1988. Such comparisons will, however, be available in the annual report module for the Pelagic Species Fishery Management Plan.

Finally, the dispute over direct sales of locally caught bigeye tuna to Japan, bypassing the local wholesale sector, relates to difficulties faced by Hawaii's wholesale seafood dealers in meeting the strong demand. The quantity of these exports, which are separate from the transshipment of bigeye tuna caught by the Japanese longline vessels discussed earlier, is not known publicly, but the problem is intensified by the role of the Honolulu fish auction acting as an agent for the local longliners. The bigeye tuna do not enter the auction floor but are shipped directly to Japan on consignment. This means local wholesalers do not have a chance to bid on the highest grade tuna, although they could make their own bilateral arrangements with the local longliners. A similar consignment operation is believed to take place at the Hilo auction. (S. Pooley (808) 943-1216)

Fourth Volume of Report Series Completed

The fourth volume in the report series "Fishery Statistics of the Western Pacific" was completed in January 1989, according to David C. Hamm, Program Manager of the Western Pacific Fishery Information Network (WPACFIN). This report series was created in 1986 to formally distribute summary fishery statistics to participating agencies in the Pacific, as part of WPACFIN's goal of helping meet the need for better fishery statistics in the Pacific. The WPACFIN was implemented by the Southwest Fisheries Center in 1981. Through cooperative efforts of numerous Pacific island fishery agencies, data collecting and processing systems have been improved significantly, and the means for sharing and distributing fishery data have been established.

Volume IV contains descriptions of the fishery data collecting and processing systems for American Samoa, Guam, the Commonwealth of

the Northern Mariana Islands, and the State of Hawaii, as well as summary fishery statistics for all of these areas for calendar year 1987. Monthly and annual summary reports of weight and value by species are reported for commercial landings for all areas. Creel survey reports for American Samoa and Guam include monthly and annual catch and effort statistics and species composition by fishing method. Also included are bar charts and line graphs showing landings of the major pelagic species groups of importance for fishery management. Additional 9-year time-series graphs are presented for important fishery statistics. A comprehensive presentation of summary fishery statistics for these four areas for 1987, Volume IV, contains 112 tables and 113 figures in over 200 pages. Volumes I-III contain similar information from 1979 through 1986 for all of these areas except American Samoa, for which only 1982-86 data are available. The information summarized in this report is used by fishery researchers, analysts, and managers as well as by the fishing industry throughout the Pacific. This report series is the only distribution of its kind in the Pacific. The document is widely used by NMFS scientists, Council staff, fishery management plan monitoring teams, Council advisory panels, and by each of the four island fishery agencies whose data are contained therein. It is also used by fishery offices in developing Pacific island nations as a reference and template for creating their own reporting capabilities.

Volume IV is available as Southwest Fisheries Center Administrative Report H-89-1, "Fishery Statistics of the Western Pacific: Volume IV, American Samoa, Commonwealth of the Northern Mariana Islands, Guam, and Hawaii, 1987," by Hamm and Computer Programmer Michael M. C. Quach. (D. Hamm (808) 943-1214)

PACIFIC FISHERIES ENVIRONMENTAL GROUP

Monterey, California

FISHERY/ENVIRONMENTAL LINKAGES

Habitat Climatology of the Brazilian Sardine Investigated

PFEG Chief Andrew Bakun and Fishery Biologist Richard Parrish have completed a study of the reproductive habitat of the Brazilian sardine (*Sardinella aurita*). This is part of a continuing series of comparative studies of coastal pelagic fish habitats around the world. The purpose is to develop a set of generalizations that can constitute a useful conceptual framework within which to unify the available fragments of experience of fishery-environmental events and interactions.

In the present study, maritime weather reports off southeastern Brazil have been summarized to yield distributions of wind stress, Ekman transport, wind mixing index, insolation, cloud cover and sea surface temperature for 2-month segments of the seasonal cycle. These are used to describe seasonal aspects of the oceanography of the region. Vigorous coastal upwelling occurs in the vicinity of Cabo Frio-Cabo São Tomé through most of the year, relaxing only during austral fall. Directly downstream of this upwelling center lies the coastal bight between Cabo Frio and Cabo Santa Marta Grande, within which offshore Ekman transport and wind-induced turbulent mixing fall to coastwise minima. The near-coastal water column within the bight, while vertically homogeneous during winter, becomes stably stratified during summer. We infer a rather enclosed circulation pattern within the bight opening rather than following the coastline into the bight interior. This coastal bight constitutes the primary reproductive habitat of the Brazilian sardine.

Peak spawning activity during summer serves to place larvae into a stable, enriched environment, where they enjoy high likelihood of retention. In the manner of achieving these advantages, the reproductive strategy of this population appears to be a nearly exact analogue to that of the Pacific sardine population spawning in the Southern California Bight and also similar to that of other sardine populations inhabiting eastern boundary current upwelling systems, in spite of its western ocean boundary location and the fact that a warmer water genus is involved.

The conclusion is that this *Sardinella* population is solving similar dominant environmental problems to those faced by the more temperate *Sardinops* and *Sardina* stocks of eastern boundary systems, only at a warmer temperature range. These findings lend support to the idea that our various fragments of experience of environmental effects on fish populations are not

unconnected anecdotes, as they are often treated, but are amenable to scientific generalization. (A. Bakun (408) 646-3311)

PHYSICAL OCEANOGRAPHY

Interannual Variability of Temperature Along the Eastern Pacific Boundary Summarized

A diagnostic study of large-scale interannual variability in surface and subsurface data along the eastern boundary of the North Pacific Ocean has been completed by David Cole (NOAA Corps); the work is co-authored by Douglas McLain (NOS Ocean Applications Group, Monterey). The study involves analysis of archived surface marine weather reports and subsurface temperature profiles for the period 1971-87.

Monthly temperature anomalies are found to be coherent in time and space over large portions of the study region, indicating the importance of large-scale ocean-atmosphere processes. In general, the 1971-76 period was anomalously cool over much of the region, excluding the 1972-73 El Niño event. In subsequent years, surface waters were warmer than average over much of the middle and high latitude regions, especially in the offshore areas during the fall and winter months.

Positive temperature anomalies extended farther north in the coastal region than in the offshore region during the El Niño episodes, while magnitudes of the positive anomalies were greatest in the subsurface layers. Negative anomalies predominated during the early part of the time series (1971-76) from the surface to at least 100 m. (Ltjg D. Cole (408) 646- 3311)

PELAGIC FISHERIES RESOURCES DIVISION

La Jolla, California

MULTISPECIES DATA COLLECTION AND EVALUATION PROGRAM

Data Submitted to Forum Fisheries Agency

The United States entered into a South Pacific Regional Tuna Treaty with 16 South Pacific island states on June 15, 1988. The Treaty allows U.S. tuna seiners to apply for licenses, and fish for yellowfin and skipjack tuna within the Treaty area. As part of the Treaty, the vessels must submit logbook reports and unloading reports to the Southwest Region and the Forum Fisheries Agency (FFA). The Southwest Region also samples landings from licensed vessels for sizes of tuna caught and composition of fish species in the catch. The data are archived on computers by the Southwest Fisheries Center. Al Coan, Mathematical Statistician and Doug Prescott, Computer Programmer, transmitted a second set of computerized data to the FFA on February 15, 1989. Data included 505 length frequency samples of over 25,000 yellowfin, bigeye and skipjack tuna, 81 species composition samples, 63 unloading logsheets and 48 logbooks received between June 15, 1988 and February 1, 1989. Approximately 59 purse seiner landings were recorded for this period. (A. Coan, FTS 893-7079)

FISHERY MONITORING AND EVALUATION PROGRAM

Indian Ocean Fisheries for Skipjack and Yellowfin Tuna Reviewed

Skipjack and yellowfin tuna are becoming increasingly important in catches of Indian Ocean tuna fisheries. The catch of these species in 1986 (262,300 MT) was three times the 1981 catch and, although some of this increase is attributable to increased catches by traditional small-scale fisheries, the major part is due to catches by the large-scale purse seine fleet which began to take a significant part of Indian Ocean tuna catches in 1983.

A detailed review of the Indian Ocean fisheries was completed by Fishery Biologist Wesley Parks of the La Jolla Laboratory. (W. Parks, FTS 893-7074)

STOCK ASSESSMENT AND FISHERY IMPACT ANALYSIS PROGRAM

Mexican Sport Fishing Captains Recognized

In late February, the annual Gardiner Foundation Awards were presented to Mexican fishing captains tagging and releasing the most marlin and sailfish in 1988. The setting for the awards ceremony was the plush billfish fishing

resort of Rancho Buena Vista located in the east Cape area near Cabo San Lucas, Baja California, Mexico.

Jim Squire, Fishery Biologist at the La Jolla Laboratory, representing the NMFS cooperative billfish tagging program, made the awards on behalf of the Gardiner Foundation. Engraved plaques and cash awards went to Captain Jesus Araiza (84 billfish tagged), Victor Garciglia (51), Gilberto Castro (49), Manuel Castro (34), Tomas Yepiz (33), and Antonio Vargas (33).

Captain Jesus Ariza has won an award in 19 of the past 20 years, and probably has tagged more billfish than any other person on earth. (J. Squire, Jr., FTS 893-7072)

Shark Assessment Methods Workshop Held

An assessment methods workshop was convened on February 15 and 16 to identify best available assessment methods for commercially exploited shark species of the U.S. west coast. Information in the literature shows that many elasmobranch species reproduce at a slow rate, and when harvested, typically become quickly overexploited. This results in rapid rise and fall of shark fisheries.

There are six important species (Pacific angel, shortfin mako, common thresher, leopard, soupfin, and spiny dogfish)in four different fisheries along the U.S. west coast. The drift gillnet fishery for common thresher and shortfin mako sharks peaked in 1982, and has been in decline since (Table 1). This fishery has, at times, also included a significant by-catch of blue sharks. A smaller California fishery for angel, soupfin, and leopard sharks has existed for many years. The catch was small, however, until 1982. Since then, angel shark gained consumer attention, and the market grew. By 1985, angel shark had replaced the thresher shark as the principal shark caught off California. An experimental longline fishery for blue and shortfin mako sharks started in 1988 off California under special permit. Success of this fishery is dependent on continued receipt of the permit. The largest west coast shark fishery is for spiny dogfish which is centered in Puget Sound, Washington. The catch has fluctuated, but remained well above several million pounds per year.

The workshop was co-sponsored by the Southwest Fisheries Center (SWFC), and the California Department of Fish and Game (CDF&G), Long Beach, and was held at the

Table 1. Commercial shark landings - west coast (landings in 1,000 pounds).

NAME	1988*	1987	1986	1985	1984	1983	1982	1981	1980	1979	1978	1977	1976
PACIFIC ANGEL	473	940	1,241	1,237	633	351	318	260	110	124	82		1
THRESHER, BIGEYE	4	25	46	120	75	107	36	10	11				
BLUE		4	3	2	4	14	58	203	192	84	36	98	10
MAKO, SHORTFIN	475	612	456	215	244	323	528	276	155	35	27	20	2
SMOOTHOUND, BROWN		13	14	33	8	14	5	24	6	2	7		
THRESHER, COMMON	605	770	1,215	1,529	1,662	1,757	2,386	1,938	1,806	736	302	129	47
COW					1	1	1	1					
HORN					1		7	2	8	21		1	
LEOPARD	4	55	66	76	69	101	71	49	40	27	35	22	14
THRESHER, PELAGIC		2		1		11							
SALMON			2	2			1						
SEVENGILL				1		1	2	3	1				
HAMMERHEAD, SMOOTH		1	3	4	6	44	1	2			1	1	
SOUPFIN	129	228	197	244	558	176	249	257	192	222	176	162	182
SPINY DOGFISH		8,071	5,009	2,838	7,649	5,399	4,592	4,832	7,141	9,445	6,522	5,813	22
UNSPECIFIED, SHARK	547	178	135	193	181	181	274	581	1,158	841	600	563	582
GREAT WHITE		1	1	3	6	1	8		2	2			
TOTAL U.S. SHARKS		10,903	8,289	6,501	11,107	8,482	8,541	8,439	10,824	11,552	7,827	6,813	862

* Incomplete data

SWFC, La Jolla, California. In attendance were 23 shark and population dynamics experts representing three fisheries centers, three universities, and five Fishery Management Councils. The participants concluded that critical information in several areas was lacking and was necessary to carry out stock assessments:

1. Common thresher. Data for thresher sharks are adequate for a preliminary assessment using a spawner-per-recruit analysis. However, for a more precise estimate, more data are needed on distribution of the adult spawning stock, size of nursery areas, and catch from the Mexican fisheries, particularly longline.

2. Mako. There is currently not enough information to perform a preliminary assessment of the shortfin mako shark population. Critical information that is lacking includes the southward extension of the nursery area off California, and the distribution of the adult spawning stock. Data from the Mexican fisheries, if available, could augment data on age structure and mortality from the California fishery.

3. All species. More biological information is needed for all shark species. This includes spawning period of females, age and growth curves, and length at first reproductive maturity. Age and growth studies, using vertebrae, are under way for several species. For angel shark, special problems with vertebrae readings, and selection of length measurement for growth, need resolving. Current research should be encouraged.

4. Fisheries data. The catch of all shark fisheries needs to be monitored. This includes both directed and incidental catches. Marine life observers, currently employed to collect information on incidental catches, should be encouraged to collect sex, length-frequency and biological data from all shark catches made on observed trips.

5. Tagging. A tagging program should be conducted to determine movement patterns of juveniles, for validation of growth and aging methods, and where appropriate, for estimates of population size and recruitment. This program should include participation by recreational fishermen, as well as a dedicated vessel and personnel for tagging sharks.

6. Stock structure. mtDNA and other biochemical studies to determine the stock structure of the world-wide common thresher shark species should be supported. (D. Holts, FTS 893-7186)

TIBURON LABORATORY

Tiburon, California

Progress on Proposed Bodega Fisheries Research Laboratory

Substantial progress has been made toward a proposed relocation of the Tiburon Laboratory to Bodega Bay. The proposed building, nominally called the Bodega Fisheries Research Laboratory (BFRL), would be located adjacent to the existing University of California's Bodega Marine Laboratory (BML). A major legal impediment was removed when the University of California recently indicated its willingness to deed the building site to the Federal government. This site is a 170 foot by 170 foot square parcel of land immediately north of BML's Fisheries and Aquaculture Building.

The first phase of the BFRL design work was completed when the engineering firm of Howard Needles Tammen and Bergendoff (HNTB) submitted their Concept Study for BFRL just before Christmas. This rather thorough document goes into considerable detail on the design features, components, requirements and costs for the new facility. The building would be a two story structure of about 44,000 square feet. Total cost of construction would be in the vicinity of seven million dollars.

The second phase has now begun and is referred to as the design services phase. The goal of this phase is to produce detailed instructions, requirements and construction drawings for BFRL which will serve as a basis for construction firms to bid on the construction work. Competitive bids from architectural and engineering firms are presently being sought for this work. The interior design will be done in-house by architects at WASC. Robert Trotter of WASC visited the Tiburon Laboratory in early February to begin this work.

Before the architectural contractor can start, they must be provided with any and all revisions to the Concept Plan prepared by HNTB. We began this process in February when the joint

BML/NMFS Design Review Committee met to go over the Concept Study and the proposed building designs. This group is charged with overseeing the design of any structure within the BML Research Enclave to make sure that it conforms with regulations set forth by the California Coastal Commission and the California Department of Parks and Recreation. The Design Review Committee must also ensure that the design of new buildings fits in with the overall architectural theme of the complex. The Committee identified some areas that need attention. The comments were constructive, and should help to make a more pleasing as well as functional structure.

FISH COMMUNITIES INVESTIGATION

1988 Predator Diet Included Many Chillipepper and Shortbelly Rockfish But Few Widow Rockfish

The occurrences of first-year juvenile rockfishes in the diet of the king salmon (*Oncorhynchus tshawytscha*) have been measured annually since 1983 by Fishery Biologists Peter Adams and Wayne Samiere of the Groundfish Communities Investigation. These measurements are being evaluated as estimates of relative year- class strength for the various species.

An analysis completed by Adams in February indicates that 1988 was a strong year for rockfish species in general (Table 1), and thus is consistent with the similar result of visual assessments in nearshore habitats reported earlier (see March-April and July-August Bimonthly Reports for 1988). Based on these figures, 1988 appears to have been a strong year for shortbelly rockfish (*Sebastes jordani*) but a relatively weak one for the widow rockfish (*S. entomelas*). Although not enumerated in the table, the chillipepper rockfish (*S. goodei*) appears to have enjoyed an exceptionally strong year in 1988. (E. Hobson, FTS 556-0565)

Table 1. Mean number of first year juvenile rockfishes (genus *Sebastes*) in the stomach contents of king salmon (*Oncorhynchus tshawytscha*) from the Gulf of the Farallones, 1983-1988 (N = the number of stomachs examined with contents).

Year	N	All species	*S. jordani*	*S. entomelaso*
1983	413	0.16	0.00	0.00
1984	503	1.61	0.34	0.02
1985	760	5.72	1.56	0.13
1986	243	0.94	0.18	0.02
1987	416	6.26	5.72	0.30
1988	320	4.51	3.15	0.04

GROUNDFISH ANALYSIS INVESTIGATIONS

Sablefish Agers Make Progress in Reducing Reader Differences

Sablefish have proven to be a very difficult species to age. Researchers at the Nanaimo British Columbia Laboratory developed criteria for aging the species from examination of otoliths using the break and burn technique. The Nanaimo group verified their aging techniques through the use of tetracycline marks. Although the aging criteria have been verified, a considerable amount of judgment must be used.

Members of the Groundfish Analysis staff of the Tiburon Laboratory began aging sablefish in 1987. They used the methodology developed by the Nanaimo group and consulted over the phone with both the Nanaimo group and the staff of the Northwest and Alaska Fisheries Center (NWAFC). The aging staffs of both the Tiburon Laboratory and NWAFC expressed concerns about their ability to properly age the species. A reference collection was developed and aged by members of the three laboratories. Agreement among readers was poor, typically about 30%, at both the Tiburon Laboratory and NWAFC. In addition, the Tiburon results tended to be different than results from the other two laboratories. Staff of the other two laboratories had met previously to work on their techniques. Because of the concerns expressed by the agers and the unacceptably high differences among readers, the NWAFC and Tiburon Laboratory decided to stop production aging until the problems could be resolved.

A workshop on sablefish aging was held at the NWAFC in Seattle, February 14-17. Anne McBride and Don Pearson of the Tiburon staff as well as agers from Nanaimo and the NWAFC participated. The general consensus was that while precision of aging is unlikely to increase, differences between laboratories could be eliminated by uniform application of aging criteria. The criteria for the early rapid growth

zone (approximately the first three annuli) are well established as are the criteria for the slow growth zone on the outer edge of the otoliths. Criteria for the middle, transition zone, are less clearly defined. The readers noted that for some reason sablefish caught off Oregon and California are more difficult to age than fish caught in northern waters. There also appeared to be a tendency for fish caught in deeper waters to be relatively difficult to age. It was also agreed that considerable interaction among readers is needed because of the necessity to often use judgment when aging the species.

The participants identified the factors that were causing results of the Tiburon readers to be different than results by readers who had more experience with the species. By the end of the workshop there was good agreement among the readers from the three laboratories. Reader agreement was increased from about 30% to 50-60%, which is acceptable.

It was agreed by the participants that aging of sablefish should resume. A regular program of otolith exchange between Tiburon and NWAFC was instituted. Within a laboratory agers will frequently consult on otoliths that are difficult to age and routinely exchange otoliths for replicate readings. At the Tiburon laboratory 50% of the otoliths were read by both agers. The NWAFC will be responsible for aging otoliths collected by surveys off the west coast and Alaska as well as samples from the Alaskan fishery. The Tiburon Laboratory will be responsible for aging otoliths collected from the West Coast fishery. (W. Lenarz, FTS 556-0565)

INFORMATION TECHNOLOGY SERVICES

MYTIME Time Tracking System Available from ITS

Over the last few years the Information Technology Services (ITS) group has been using the MYTIME Data System. The application was developed on the Molecular 32X to record, track, and report on individual day-to-day job activities based on their performance plans.

The MYTIME Data System has been converted to run on IBM PC or compatible systems. It is written in dBASEIII and uses some of the dBASEIII interactive commands. It is required that you have an IBM PC or compatible system running at least DOS 2.X, and that you have dBASEIII Plus installed on your PC.

The application allows any user to tailor it to their own job. Users set up tables with performance plan elements, performance plan activities, and groups or individuals they work for. These tables are the basis for data entry and reports.

The application is completely menu driven. Interactive data entry forms are used to enter daily activities by date, requester, time spent, element code, activity code, group code, and description of the work performed.

Several reports are available. Interactive report selection routines allow you to produce reports by the percentage of time spent for performance plan elements, activities, work group, and by a detailed list of each activity day-by-day. Each report allows the user to select the desired range of dates.

The next step will be to compile the application into an executable format with dBASEIV version 1.1 when it becomes available. Then the application can be distributed to users that do not have dBASE running on their system.

If you are interested in finding out more about this application or about setting it up for your use, contact Rob Bistodeau in the ITS group, La Jolla. (R. Bistodeau, FTS 893-7055)

STATUS OF PUBLICATIONS

Published

Bernard, Hannah J. and Aleta A. Hohn. 1989. Differences in feeding habits between pregnant and lactating spotted dolphins (*Stenella attenuata*). J. Mamm. 70(1):211-215.

Boehlert, George W. 1989. Drift net problems spread to South Pacific. Hawaii Fish. News 13(12):34.

Boehlert, George W., and Takashi Sasaki. 1988. Pelagic biogeography of the armorhead, *Pseudopentaceros wheeleri*, and recruitment to isolated seamounts in the North Pacific Ocean. Fish. Bull., U.S. 86:453-465.

The pelagic armorhead, *Pseudopentaceros wheeleri*, occurs widely in the North Pacific Ocean. Benthic specimens have been taken from

Japan, the Hawaiian Archipelago, and the west coast of North America, but the main reproductive populations are located on southern Emperor-northern Hawaiian Ridge seamounts between lat. 29° and 35°N. The period between spawning and recruitment to the seamounts is apparently between 1.5 and 2.5 years, suggesting an extended pelagic existence. We describe the distributional patterns in the North Pacific based upon over 30 years of published and unpublished records. The majority of pelagic specimens are captured in the subarctic water mass in the northeast Pacific. Based upon the distributional patterns and the oceanography of the North Pacific, we propose migratory paths for both the main population and for the individuals that occur rarely in other locations. The long pelagic period and variability in ocean conditions may play an important role in recruitment to seamounts and the variability in year-class strength for this species.

Edwards, Elizabeth F. 1989. Using tuna-vessel observer data to detect trends in abundance of dolphin populations: History and researchg to date (1988). U.S. Dep. Commer., NOAA Tech. Memo., NOAA-TM-NMFS-SWFC-122, 123 p.

Hobson, E. S. 1989. Predation on ocean krill. Science, 243:237.

Dense concentrations of krill (*Meganyctiphanes norvegica*) recently reported at the bottom of submarine canyons on Georges Bank may be major prey of fishes on the bank as a result of their diel vertical migrations. As is known to occur among related species in similar settings elsewhere, when these organisms are in the surface water at night many are likely to be carried by currents (or swim) over the adjacent bank. And any that are above the bank in the morning are likely to be trapped by the bank-top when they attempt to return to their normal daytime depths, and there become vulnerable to predatory fishes.

Myrick, Jr., A. C. 1988. Is tissue resorption and replacement in permanent teeth of mammals caused by stress-induced hypocalcemia? *In:* Z. Davidovitch (ed.), The biological mechanisms of tooth eruption and root resorption, p. 379-389. EBSCO Media, Birmingham, AL.

Natural resorption and repair of tissues in permanent teeth of mammals are often attributed to restricted odontoclastic and cementoclastic activity under localized control. I suggest that in addition to the well known local causes, systemic alteration of dental tissues caused by regulation of blood-serum calcium is common also. This newly recognized type of tissue alteration apparently affects teeth internally and externally, and interferes with normal rates of tissue calcification as well. Causal connections between systemic alteration in tooth tissues and stress-induced low serum calcium (hypocalcemia) in mammals are indicated by this study but are not directly demonstrated. Two theoretical models are presented that explain how certain manifestations of stress may produce different responses and results.

Reddy, Michelle L. 1989. Population monitoring of the Hawaiian monk seal, *Monachus schauinslandi*, and captive maintenance project for female pups at Kure Atoll, 1987. U.S. Dep. Commer., NOAA Tech. Memo., NOAA-TM-NMFS-SWFC-123, 39 p.

Approved, Science and Research Director, SWR

Hunter, J. Roe, Beverly J. Macewicz and Carol A. Kimbrell. Fecundity, and other aspects of the reproduction of sablefish, *Anoplopoma fimbria*, in central California waters. For consideration for publication in California Cooperative Oceanic Fisheries Investigations Reports.

Huppert, Daniel D. Measuring the value of fish to anglers: application to central California anadromous species.l For consideration for publication in Marine Resource Economics.

Laurs, R. Michael. Satellite remote sensing applications to North Pacific albacore, *Thunnus alalunga* (Bonnaterre). For consideration as a FAO Fisheries Report.

Lo, Nancy C. H. and Richard D. Methot. Spawning biomass of the northern anchovy in 1988. For consideration for publication in California Cooperative Oceanic Fisheries Investigations Reports.

Parrish, Frank A. Identification of habitat of juvenile snappers in Hawaii. For consideration for publication in Fishery Bulletin, U.S.

Parrish, Richard H. (Chairman), Norman W. Bartoo, Samuel F. Herrick, Jr., Pierre M. Kleiber, R. Michael Laurs and Jerry A. Wetherall. Albacore management information document. For publication as a U.S. Dep. Commer., NOAA Tech. Memo., NOAA-TM- NMFS-SWFC.

Somerton, David A. and Donald R. Kobayashi. A method for correcting catches of fish larvae for the size selection of plankton nets. For consideration for publication in Fishery Bulletin, U.S.

Thomson, Cynthia J. Use of the generalized Neyman distribution for specifying fishing quality in recreation demand models. For consideration for publication in the North American Journal of Fisheries Management.

Administrative Reports

Edwards, Elizabeth F., Bruce E. Whalen and Christina Perrin. 1989. Effects of percent coverage on estimates of cumulative mortality: Results from subsampling the 1987 data base. SWFC Admin. Rep., La Jolla, LJ-89-05.

Fougner, Svein and George Boehlert. 1989. Objective frameworks for ecosystem program planning in the Southwest Region. SWFC Admin. Rep., La Jolla, LJ-89-02.

Hamm, David C., and Michael M. C. Quach. 1989. Fishery statistics of the western Pacific, volume IV. Territory of American Samoa (1987), Commonwealth of the Northern Mariana Islands (1987), Territory of Guam (1987), and State of Hawaii (1987). SWFC Admin. Rep., Honolulu, H-89-1, var. pag.

Kasaoka, Laurel D. 1989. Linear programming model for the Northwestern Hawaiian Islands bottomfish fishery. SWFC Admin. Rep., Honolulu, H-89-2C, var. pag.

Mackett, David. 1989. Results of the meeting of the joint SWFC/SWR/NWR/NWAFC ecosystems planning task force, September 9, 1987. SWFC Admin. Rep., La Jolla, LJ-89-03.

Mackett, D. J. and George Boehlert. 1989. A report on the NOAA Workshop for Ecosystems Research Program Planning, April 26- 28, 1988. SWFC Admin. Rep., La Jolla, LJ-89-01.

Oliver, Charles W. and Elizabeth F. Edwards. 1989. Effects of including dolphins seriously injured and of unknown status in mortality estimates. SWFC Admin. Rep., La Jolla, LJ-89-04.

Polovina, Jeffrey J. and Robert B. Moffitt. 1989. Status of lobster stocks in the Northwestern Hawaiian Islands, 1988. SWFC Admin. Rep., Honolulu, H-89-3, 10 p.

Translation

Okiyama, Muneo (editor). 1988. An atlas of the early stage fishes in Japan. Tokai University Press, Tokyo, Japan, 1154 p. [Translation of Introduction and selected pages of the book.] (Engl. transl. by W. G. Van Campen, 1989, 25 p., Transl. No. 130; available Southwest Fish. Cent. Honolulu Lab., Natl. Mar. Fish. Serv., NOAA, Honolulu, HI 96822-2396.)

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